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Technical Report

NOAA/NATIONAL HURRICANE AND EXPERIMENTAL METEOROLOGICAL LABORATORY

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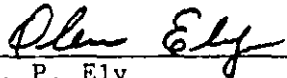
NOAA/NATIONAL HURRICANE AND EXPERIMENTAL
METEOROLOGICAL LABORATORY

Prepared For

DATA SYSTEMS LABORATORY
MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

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APPROVED:



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INTRODUCTION

The National Hurricane and Experimental Meteorological Laboratory (NHEML), located in Miami, Florida, operates under the direction of the Environmental Research Laboratories (ERL) in Boulder, Colorado. The research programs of this laboratory concentrate on two atmospheric phenomena of the tropical troposphere: hurricanes and cumulus convection, together with the atmospheric environments in which they occur and with which they interact. These programs include basic research in the description of these phenomena and applied research in their prediction and potential beneficial modification. Special observational programs use aircraft of the Research Facilities Center of ERL to acquire data. A current major effort is the development of mathematical models through high-speed, larger capacity computers. These models simulate the development, structure, and behavior of hurricanes and cumulus clouds, both in their natural state and when experimentally modified. These studies and models are also used to improve prediction capability.

NHEML is partitioned into four working groups, as shown in Figure 1. Two important and logical parts of the research programs of NHEML are the experimental program in hurricane modification (STORMFURY) and the program in cumulus modification (FACE). The ultimate goal of STORMFURY is the reduction of the maximum winds associated with the eye-wall of hurricanes; the goal of FACE is to acquire a thorough understanding of cumulus cloud behavior that will enable NHEML to increase precipitation from cumulus clouds. Since it is the convective-scale motions within the hurricane that are modified, these two programs are interrelated in such a way that their combination within a single laboratory is mutually beneficial. These experimental programs also make extensive use of the nearby ERL Research Facilities Center.

NHEML also interacts with the National Hurricane Center (NHC) of the National Weather Service (NWS) in the problems of hurricane prediction, and with the Sea-Air Interaction Laboratory (SAIL) in

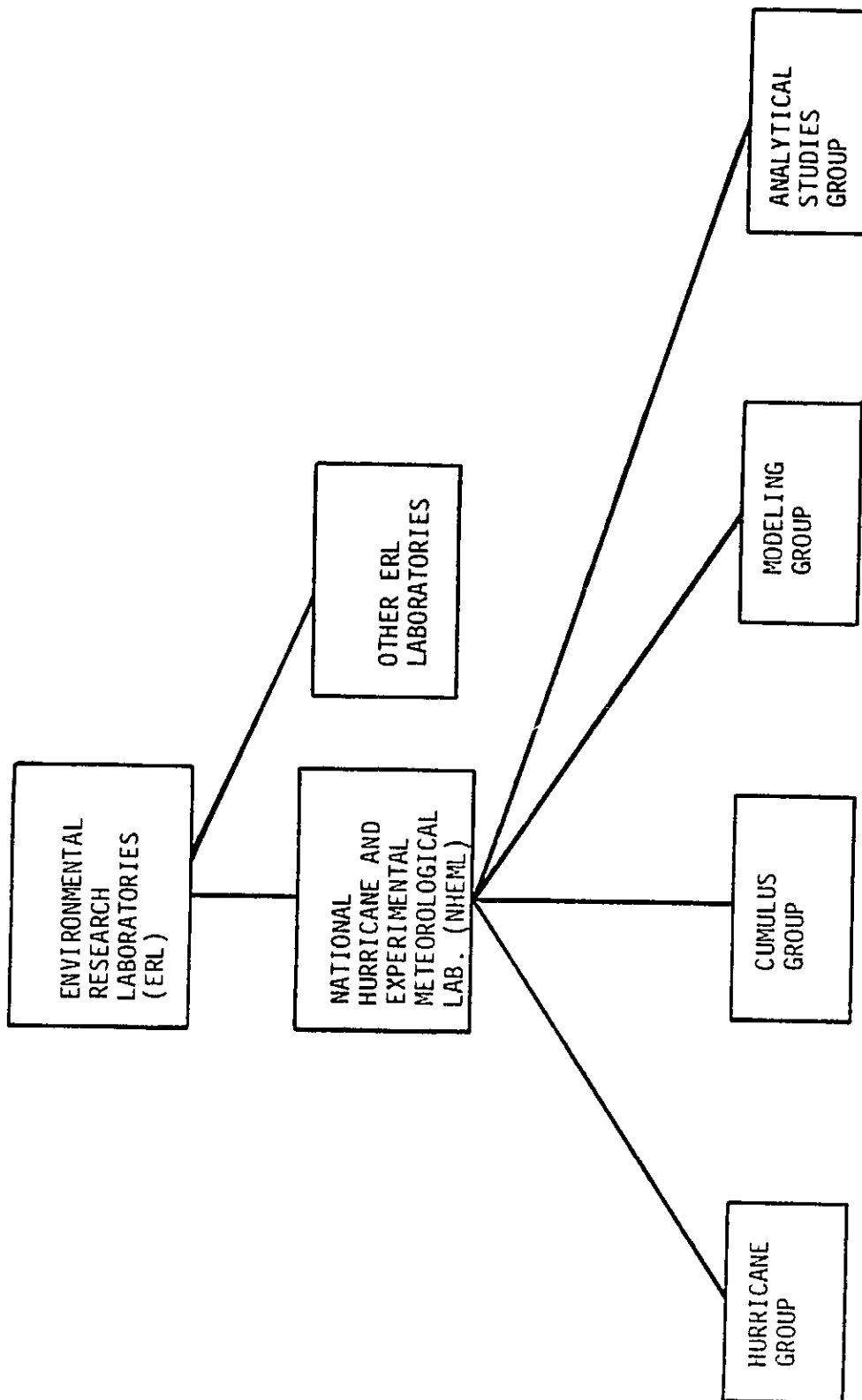


FIGURE 1. ORGANIZATIONAL STRUCTURE OF NHEML

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problems of boundary layer energy transfers and hurricane storm surge.

Figure 2 depicts the operational structure of NHEML and related agencies.

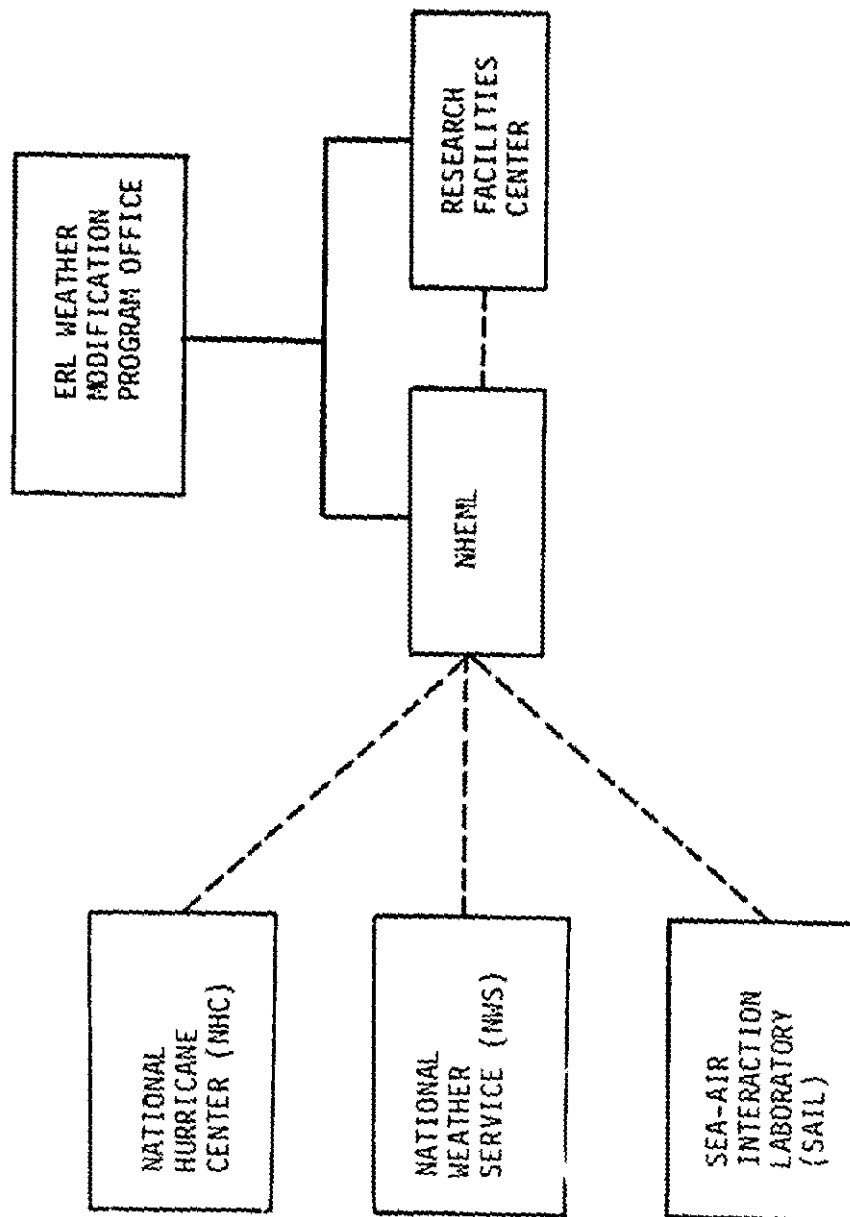


FIGURE 2. OPERATIONAL STRUCTURE OF NHEML ACTIVITIES

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1. DATA GENERATOR ELEMENTS

NOAA aircraft used by NHEML to collect data for experiments include the use of two WP-3Ds and a WC-130B. Instrumentation with which each aircraft is equipped is described below:

• NOAA WP-3D (43RF) (Plane A, Low Level) Instrumentation

I. Meteorological Sensors

Temperature	(Rosemount, total temperature)
Pressure	(Static-dynamic, Garrett)
Dewpoint	(General Eastern)
Sideslip	
Winds	(Omega-INS TAS computed)
Vertical wind system	(High resolution angle of attack, pitch angle, vertical acceleration)

II. Cloud Physics

Cloud droplet spectrum	(PMS Knollenberg 2-D probe)
Hydrometeor size spectrum	(PMS Knollenberg 2-D probe)
Hydrometeor size spectrum	(Foil impactor - MRI)
Cloud liquid water	(Johnson-Williams hot wire)
Total water content	(Lyman-alpha probe)
Total liquid water content	(Merceret-Schricker nimbiometer)
Ice-water discriminator	(Mee Industries)
Cloud condensation nuclei CTR	(Mee Industries)
Bulk water sampling system	
Nuclei	(General Electric E-1)
Total dust	(General Electric)
Ice	(NCAR-Acoustic or MEE)
Condensation	(Diffusion, 1% super sat)
Millipore filter system	

III. Radiation

Sea surface temperature	(Barnes 14-335)
CO ₂ air temperature	(Barnes 14-335)

IV. Radar (Digitized and Video Recorded)

C-band PPI belly 360-deg scan (horizontal) fan beam radar
X-band RHI tail 360-deg scan (vertical) radar
C-band PPI nose 240-deg scan conical

V. Miscellaneous

Gust probe
Airborne expendable bathythermograph launch mechanism
Flare seeding system (internal)
Photography (nose, side, vertical)
Laser altimeter

- NOAA WP-3D (42RF) (Plane B, High Level) Instrumentation
Used for STORMFURY

I. Meteorological Sensors

Temperature	(Rosemount, total temperature)
Pressure	(Static-dynamic, Garrett)
Dewpoint	(General Eastern)
Sideslip	
Winds	(Omega-INS TAS computed)
Wind-temperature-humidity profile	(Omega dropwindsonde)
Vertical wind system	(High resolution angle of attack, pitch angle, vertical acceleration)

II. Cloud Physics

Cloud droplet spectrum	(PMS Knollenberg 2-D probe)
Hydrometeor size spectrum	(PMS Knollenberg 2-D probe)
Small cloud droplet spectrum	(PMS axially scattering probe)
Hydrometeor size spectrum	(Foil Impactor - MRI)
Cloud liquid water	(Johnson-Williams hot wire)
Total water content	(Lyman-alpha probe)
Total liquid water content	(Merceret-Schricker nimbiometer)
Ice particle counter	(MEE)
Cloud particle replicator	(Formvar-DRI)

III. Radiation

Sea surface temperature	(Barnes 14-335)
CO ₂ air temperature	(Barnes 14-335)
Microwave radiometer	

IV. Radar (Digitized and Video-Recorded)

C-band PPI belly 360-deg scan (horizontal) fan beam radar
X-band RHI tail 360-deg scan (vertical) radar
C-band PPI nose 360-deg scan conical

V. Miscellaneous

Airborne expendable bathythermograph launch mechanism
Flare seeding system (internal)
Photography (nose, side, vertical)

• NOAA WC-130B Instrumentation for STORMFURY

I. Meteorological Sensors

Temperature	(Rosemount, total temperature)
Pressure	(Rosemount, Kollsman)
Dewpoint	· Cambridge, EG&G thermoelectric hygrometer)
Winds	(Omega-INS TAS computed)
Vertical wind system	AWRS

II. Cloud Physics

Hydrometeor size spectrum	(PMS Knollenberg 1-D probe)
Cloud liquid water	(Johnson-Williams hot wire)
Total water content	(EG&G Lyman-alpha)
Total liquid water content	(Merceret-Schricker nimbiometer)
Hydrometeor size spectrum	(Foil impactor - MRI)
Ice water discriminator	(MEE Industries)
Cloud particle replicator	(MEE Industries)
Millipore filter system	
Bulk water sampler	
Nuclei	
Total dust	(General Electric)
Ice	(MEE Industries)
Condensation	(Diffusion, 1% super saturated)
Ice nucleus counter	(MEE Industries)

III. Radiation

Sea surface temperature	(Barnes 14-335)
CO ₂ air temperature	(Barnes 14-335)

IV. Radar

C-band PPI nose 240-deg scan (video tape and digitized)

V. Miscellaneous

Flare seeding system (internal)
Photography (side-looking, forward)

2. SPACE DATA PROCESSING ELEMENTS

Not applicable

3. SPACE DATA STORAGE ELEMENTS

Not applicable

4. SPACE DATA HANDLING ELEMENTS

Not applicable

5. SPACE-TO-GROUND COMMUNICATION ELEMENTS

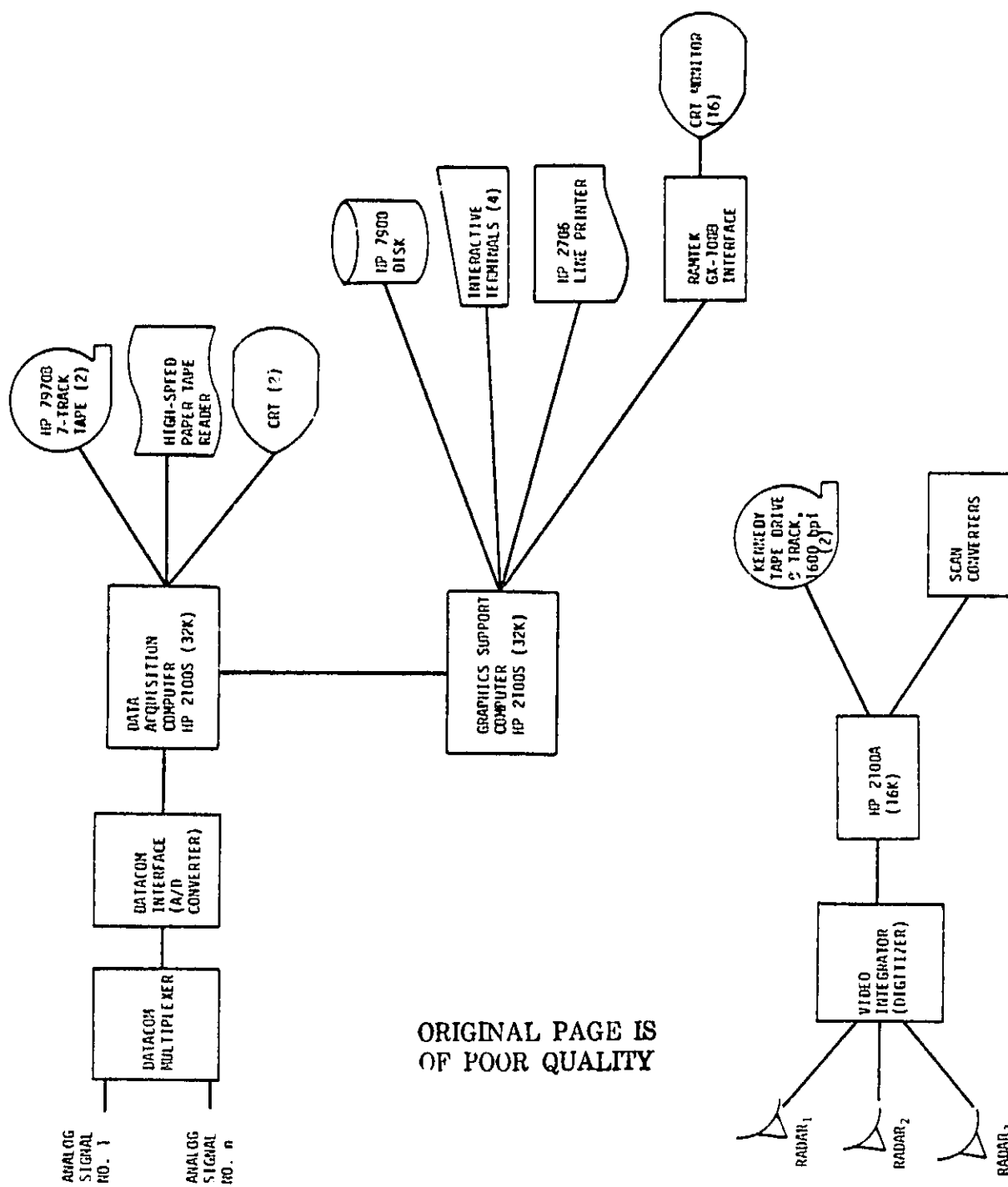
Not applicable

6. PREPROCESSING ELEMENTS

Onboard data handling, data storage, and preprocessing elements are all considered under the heading of preprocessing herein.

Data collected on board the aircraft are preprocessed by means of three HP 2100A computers. One of the computers is used by the radar and the remaining two operate as a dual system, with one used for recording data and the other used for real-time parameter analysis and data display. In addition, the real-time computer is designed to assume recording responsibilities if the recording computer should malfunction. Data that are collected from each sensor are converted from analog to digital values. The data are then made available for real-time display and written on digital magnetic tape in computer-compatible format.

The preprocessing elements are depicted in Figure 6-1.



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FIGURE 6-1. PREPROCESSING ELEMENTS

7. NHEML PROCESSING ELEMENTS

The processing elements presented in this section are those that exist at the NHEML facility located at Miami, Florida.

7.1 CURRENT CAPABILITY

The computer system configuration at NHEML is depicted in Figure 7-1. Specific hardware/software capabilities are listed below.

7.1.1 Hardware Capability

Varian 620/F configured as follows:

- 48K word main memory
- 2 7-track, 556-bpi tape drives
- 1 Diablo 37 disk drive
- 1 line printer (600 lines/min)
- 1 Remex card reader
- 1 ASR-33 teletype
- 1 Statos-31 on-line printer/plotter

Other equipment used in timesharing with the CDC 6600 and XDS 940 computer systems is as follows:

- Interactive (asynchronous) terminals tied to CDC 6600 and XDS 940 at ERL headquarters in Boulder, Colorado:
 - ▲ 1 Tektronix 4012 terminal with hardcopy device
 - ▲ 2 Decwriter terminals
- RJE (synchronous) terminal:
 - ▲ 1 Unitek system
- 1 CDC printer (600 lines/min)
- 1 Documentation card reader
- 2 7-Track tape drives.

7.1.2 Software Capability

Software and algorithms for the above systems are as follows:

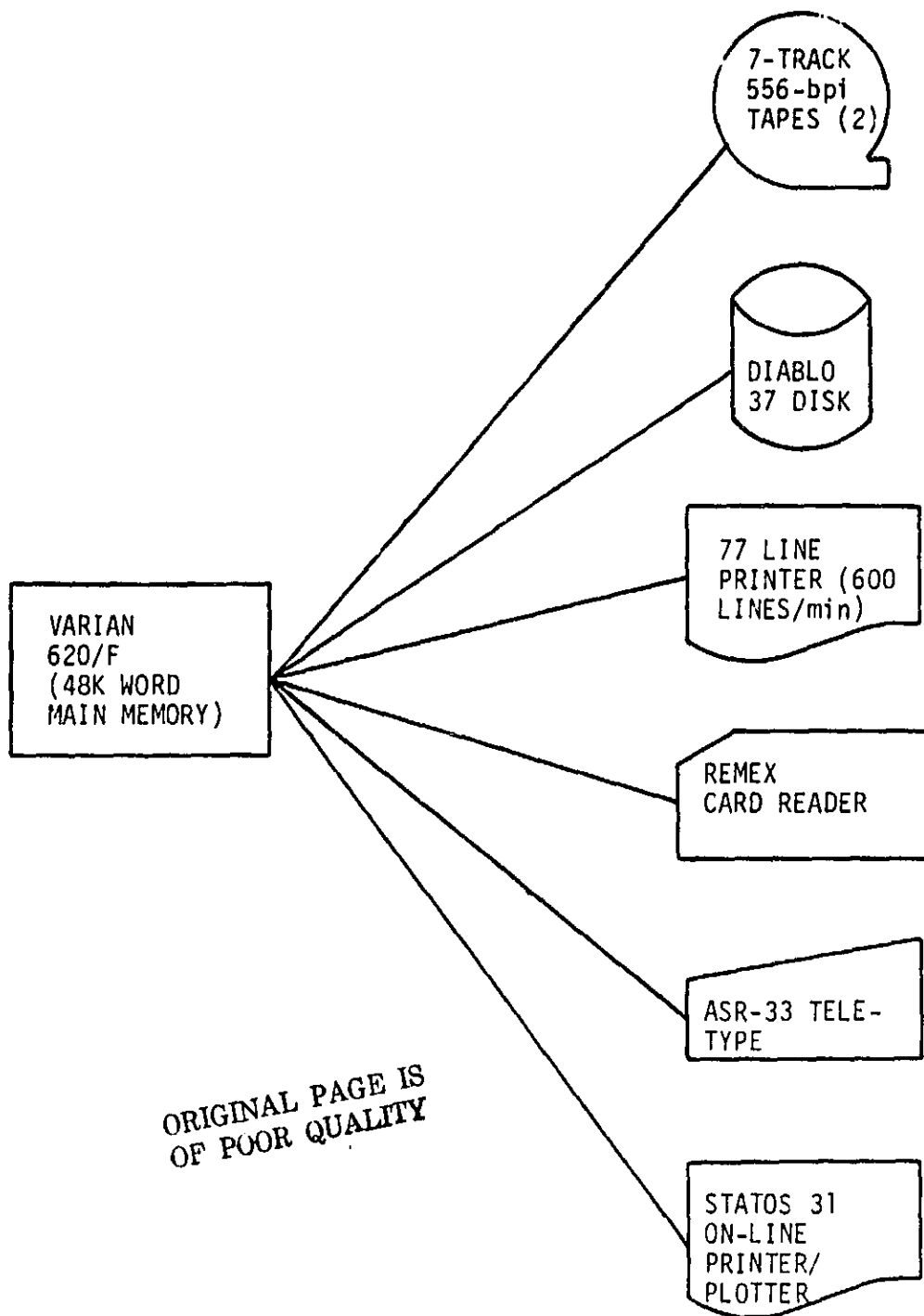


FIGURE 7-1. NHEML COMPUTER FACILITY CONFIGURATION

- Varian 620/F MOS operating system
- Highly specialized plotting package (developed in-house)
- Data management system (developed in-house)
- BMD statistical package.

7.2 CURRENT WORKLOAD

- Varian system open 24 hr/day, 7 days/week
 - ▲ Maintenance performed on an as-needed basis (no scheduled preventive maintenance)
 - ▲ Strictly used for research and processing data collected for experiments; no internal processing performed
- RJE terminal used about 20 hr/day. Preventive maintenance requires 4 hr monthly
- Interactive terminals available 24 hr/day, 7 days/week; no scheduled preventive maintenance performed.

7.3 PROJECTED CAPABILITY TO 1980

7.3.1 Hardware

- Houston Instruments off-line plotter with DPES-3 7-track tape drive
- Interactive graphics system, which has the capability to produce the following output:
 - ▲ CRT display
 - ▲ Standard plot tape
 - ▲ Printed output
 - ▲ Plotted output from tape.
- Possibly acquire a CDC 6600 system from ERL in Suitland, Maryland. This would allow discontinued use of timesharing with ERL facilities in Boulder, Colorado. If this system is not acquired, it will be necessary to buy a system since the Varian is currently saturated with its workload.

7.3.2 Software

- Improvements to system to process data from airborne measurements
- Modifications to plotting software.

7.4 PROJECTED WORKLOAD TO 1980

- If a second CDC is obtained, it will probably be used for modeling to eliminate the need for timesharing with ERL headquarters.
- Modeling and data reduction/analysis currently saturates the Varian system. More timesharing terminals may be added, but these will merely add convenience for the users and will not actually improve the computer resource situation.

7.5 PROJECTED CAPABILITY (1985)

7.5.1 Hardware

Not available

7.5.2 Software

Not available

7.6 PROJECTED WORKLOAD (1985)

7.6.1 Hardware

Not available

7.6.2 Software

Not available

8. DATA BASE SYSTEM

An in-house developed Data Management System is used at NHEML to process data.

9. INFORMATION DISTRIBUTION ELEMENTS

Distribution of information acquired in NHEML experiments is primarily in the form of magnetic tapes that are generated either on aircraft or at ground sites. The Varian system may be used to process this data or the communication capabilities of NHEML may be used for either remote job entry to the ERL CDC 6600 or for interactive processing via the CDC 6600 or the XDS 940.

10. INFORMATION PRESENTATION ELEMENTS

Devices that provide the presentation of information at NHEML are as follows:

- Varian line printer (600 lines/min)
- Statos-31 printer/plotter
- CDC printer available on Unitek RJE system
- 2 Decwriter interactive terminals
- 1 Tektronix 4012 terminal with hardcopy device.